THE PRIMARY PARTNERS

Three primary partners who have signed a mutual Memorandum of Understanding and currently comprise the National Cave and Karst Research Institute:

National Park Service (NPS), City of Carlsbad, and New Mexico Institute of Mining and Technology (New Mexico Tech).

The NPS has the leading role in establishing the Institute and provides nearly half of the funding and most of the current staff support. The NPS also offers internationally recognized expertise in cave and karst stewardship policies and needs. The City of Carlsbad has provided advocacy and secured funding for NCKRI. The City is responsible for managing the design and construction of the Institute's headquarters building in consultation with the other primary partners. New Mexico Tech supplies the academic and research foundation for NCKRI. The State of New Mexico contributes NCKRI operating funds through New Mexico Tech. Currently, New Mexico Tech provides one full-time staff position to the Institute and will fill a second full-time position (Visiting Chief Scientist) in Spring 2004.

NATIONAL PARK SERVICE, GEOLOGIC RESOURCES DIVISION

The Park Service cooperates with partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout this country and the world.
FROM THE NATIONAL PARK SERVICE MISSION STATEMENT

The National Park Service is working through the National Cave and Karst Research Institute to build a broad coalition of partners who will help promote the National Park Service's mission by enhancing the understanding and conservation of karst terrains and ecosystems throughout the world. The Institute will assist science-based stewardship in national parks and elsewhere. The National Park Service welcomes this exceptional opportunity to work with other cave and karst researchers, educators, and land managers to improve and expand Best Management Practices.

Congress tasked the National Park Service with establishing NCKRI and the responsibility for this effort fell upon the Geologic Resources Division. The Division enthusiastically embraced the responsibility, in large part because of the support and attention given by Division's National Cave Program Coordinator Ron Kerbo. In 2000, the Division recruited an administrator, Zelda Chapman Bailey, with experience in program development and partnerships as the two-year interim director and began the process of developing the incipient institution.

In 2003, with the groundwork completed, the National Park Service began to work on Institute staffing, the design and construction of a headquarters building, and identifying a partner to manage the day-to-day operation. The hiring of Louise Hose as the Institute's first permanent director, marked the organization's transition from its Initial Development Phase based in Denver, Colorado, to the current Gearing-Up Phase based in Carlsbad, New Mexico.

In February, the NPS signed a MOU with New Mexico Institute of Mining and Technology and the City of Carlsbad that provides coordination between the three entities to facilitate the development and management of the National Cave and Karst Research Institute. The MOU established the basis for cooperation among the parties.

Also in 2003, nearly $2 million in federal funding for the NCKRI Headquarters building came through NPS appropriations. The NPS now provides an annual

operating base of approximately $350,000 (matching the New Mexico annual funding) within the Geologic Resources Division budget. The Geologic Resources Division supports the Institute with staff and other resources. During the past year Division Chief Dave Shaver, along with specialists Ed Kassman and Ron Kerbo, worked closely with the Institute staff to attract partners, hire staff, provide technical assistance and "grow" the organization. The Division's Washington Liaison, Lindsay McClelland, assists with the Institute's needs and interactions with D.C.-based offices and programs. Division staff is also working to complete the process necessary to transfer federal construction funds to the City of Carlsbad. The City will build and own the facility and Institute staff will work there under a long-term lease.

Establishment of the Institute furthers the mission of the National Park Service to preserve and protect the resources of the national park system, using the best available scientific knowledge, for the benefit of future generations. However, the Institute's legislative charter also directs it to move beyond the realm of a federal agency and to connect with academic, scientific, and educational resources in a way not previously attempted by the National Park Service.

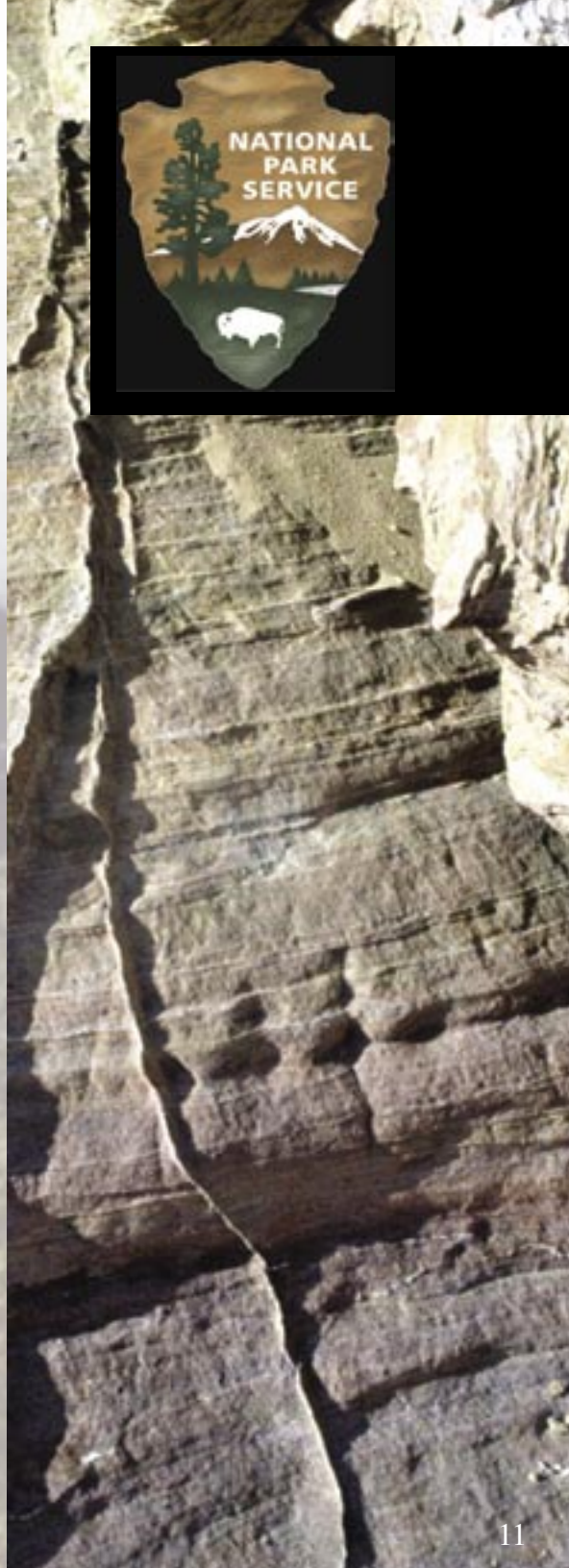
The October Vision Building Workshop in Shepherdstown, West Virginia, reflected the latitude and broad public-private partnership contemplated by the Act. Geologic Resources Division staff worked closely with our primary partner, New Mexico Tech, developing the invitation list and soliciting participants, and preparing the agenda, materials, and goals for the workshop. The workshop effort was praised by the over 20 diverse stakeholders who participated and provided input to both organizations about the vision they hold for the Institute.

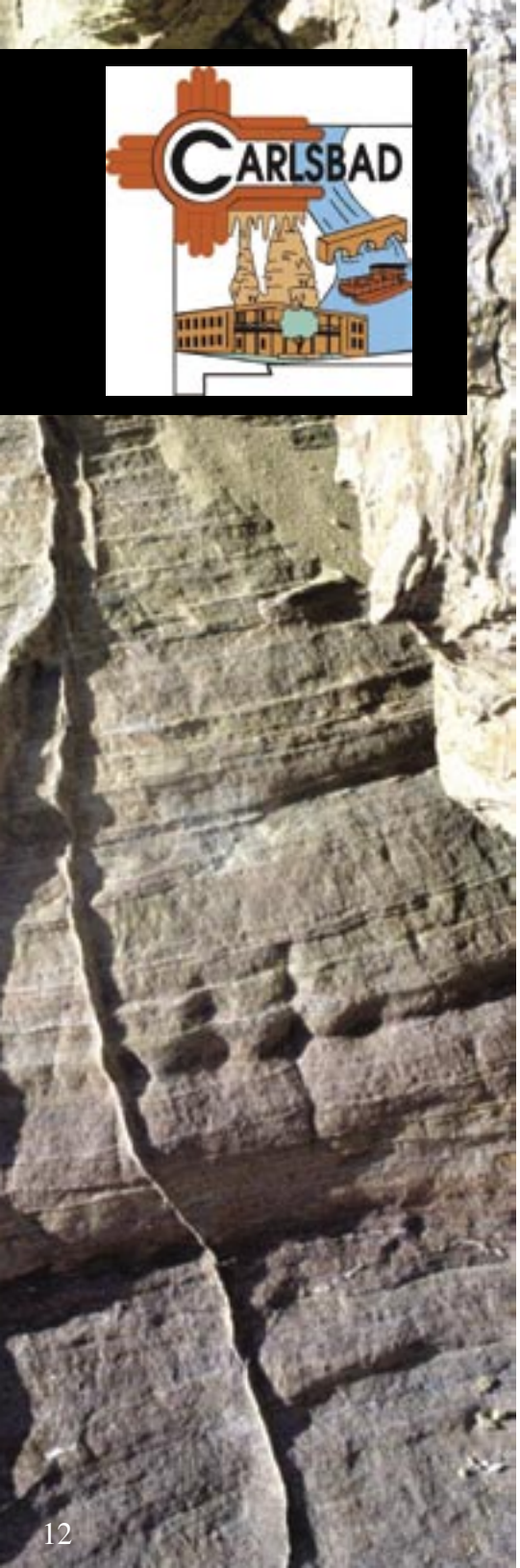
The Gearing-Up Phase is expected to last several years. During that time, the NPS will continue to shepherd the Institute as it continues to grow and evolve. A major goal for this phase will be formalizing an arrangement with the primary partner, New Mexico Tech, that will develop and carry out many of the NCKRI's activities. Division staff will continue to oversee the Institute and staff from the parks with major cave resources will work with it on issues regarding resource management, research, and education. Once the day-to-day management responsibilities are transferred to an administrative partner, the NPS role will shift towards oversight, allowing the Institute the independence it needs to effectively carry out its mission. Until that partner comes on board, the NPS remains the sole administrator of NCKRI in consultation with the other primary partners.

Dave Shaver, Chief of Geologic Resources Division
National Park Service

NPS GEOLOGIC RESOURCES DIVISION STAFF CURRENTLY WORKING WITH THE INSTITUTE:

TITLE	NAME
Carlsbad, New Mexico	
Director, National Cave and Karst Institute	Louise Hose
Administrative Support	Roger Scott
Denver, Colorado	
Division Chief - NPS Lead	Dave Shaver
Cave Resource Specialist	Ron Kerbo
Policy/Regs. Specialist	Ed Kassman
Program Analyst	Diana Diedrichs
Secretary	Lindy Allen
Washington, D.C.	
Division Washington, D.C., Liaison	Lindsay McClelland





THE CITY OF CARSBAD, NEW MEXICO

The City of Carlsbad helped lead the efforts to pass the National Cave and Karst Research Institute Act of 1998 and to establish the first, and to date most significant, non-federal funding. We have been involved with the Institute since its beginning and remain committed to help move NCKRI ahead as the leader in cave and karst research and education. We recognize from our experiences with several other national research centers sited in Carlsbad (i.e., Los Alamos National Laboratory, Sandia National Laboratory, Carlsbad Environmental Monitoring and Research Center) the positive benefits to our community that will come from engaging as full partners in NCKRI.

Carlsbad has a long and proud tradition of working with the National Park Service (NPS) in promoting and protecting our two local national parks (Carlsbad Caverns and Guadalupe Mountains). In 1990, I, as mayor, appointed Chuck Wiggins as the first Chairman of the National Cave and Karst Research Institute Committee. Our partnership with the NPS towards establishing NCKRI began in 2000 when representatives of the City's Department of Development met with Interim Director Zelda Bailey and other NPS representatives. Carlsbad's mayor at the time, Gary Perkowski, and New Mexico State Representative John Heaton carried that interest further with a request for state funding. Subsequent efforts by Senator Jeff Bingaman's and the late Congressman Joe Skeen's offices, representatives of New Mexico Institute of Mining and Technology (New Mexico Tech) and New Mexico State University (NMSU) focused on office space, a proposed building site, funding, and partnerships.

Over the next two years, the dedicated efforts of the leaders of Carlsbad and the State of New Mexico paid off and the Institute became a reality. Temporarily housed on the campus of NMSU's Carlsbad Environmental Monitoring and Research Center, NCKRI began receiving funding from the State of New Mexico that included annual operational appropriations of $350,000 as well as $1.340M for the construction of a building. The City of Carlsbad also pledged nearly $1M of in-kind services toward the building.
The City of Carlsbad has been very involved with the funding, design, and construction of the NCKRI headquarters building and has focused on the Institute as another attraction to bring visitors and jobs to the area. We have provided major support towards legislatively establishing and funding the Institute and deeply care about its future.

In 2003, the City of Carlsbad continued strong support for NCKRI. We worked hand-in-hand with the NPS and New Mexico Tech in finalizing the location for the Institute's building and contracted with an architect and engineering firm to design and construct the building. The City has also pledged support for the development of a business plan for the Institute as well as legislation to secure long-term operating funds from the State of New Mexico.

The Institute building will anchor the City's major, riverfront redevelopment project, The Cascades, and is scheduled for construction on a parallel track. The initial phase of The Cascades has gone out to bid and city officials hope to begin construction on that commercial effort as well as the NCKRI headquarters by summer 2004.

As we start the new year of 2004, the City is working closely with the Institute Director and New Mexico Tech staff to review preliminary designs and subsequent revisions. The architects are focusing on Construction Documents, which should be completed by mid-2004.

The City of Carlsbad takes pride in its important role in establishing the National Cave and Karst Research Institute and we look forward to helping it grow into an internationally recognized center attracting researchers, educators, and visitors from around the world.

Bob Forrest, Mayor **City of Carlsbad**

CURRENT CITY OF CARLSBAD STAFF WORKING DIRECTLY WITH THE INSTITUTE:

TITLE	NAME
Mayor	Bob Forrest
City Administrator	Jon Tully

NEW MEXICO INSTITUTE OF MINING AND TECHNOLOGY

The New Mexico Institute of Mining and Technology (New Mexico Tech) worked hard in 2003 to assist in the development of the National Cave and Karst Research Institute (NCKRI) and in efforts to develop its own program in Cave and Karst Studies. The biggest challenge was to develop clear relationships between NCKRI and its academic partner and to establish methodologies for accomplishing joint tasks. The particular type of arrangement between NCKRI and New Mexico Tech had no precedent, thus all functions required creation *de novo*.

Two staff positions currently represent NCKRI activities at New Mexico Tech: Dr. Penelope Boston, professor in the Earth and Environmental Sciences Department in residence at New Mexico Tech, and Dr. Lewis Land, karst hydrologist for the New Mexico Bureau of Geology and Mineral Resources who is in residence at Carlsbad. At the end of December 2003, Ms. Rosemary Baca was hired as a part-time assistant in residence at New Mexico Tech to facilitate joint NCKRI and New Mexico Tech cave and karst related activities between the two institutions.

New Mexico Tech conducted the search for the new Chief Scientist position through the New Mexico Tech hiring process. The Chief Scientist will be in residence at Carlsbad. Interview candidates were identified and interviews scheduled for early 2004.

Teaching and Public Outreach Activities

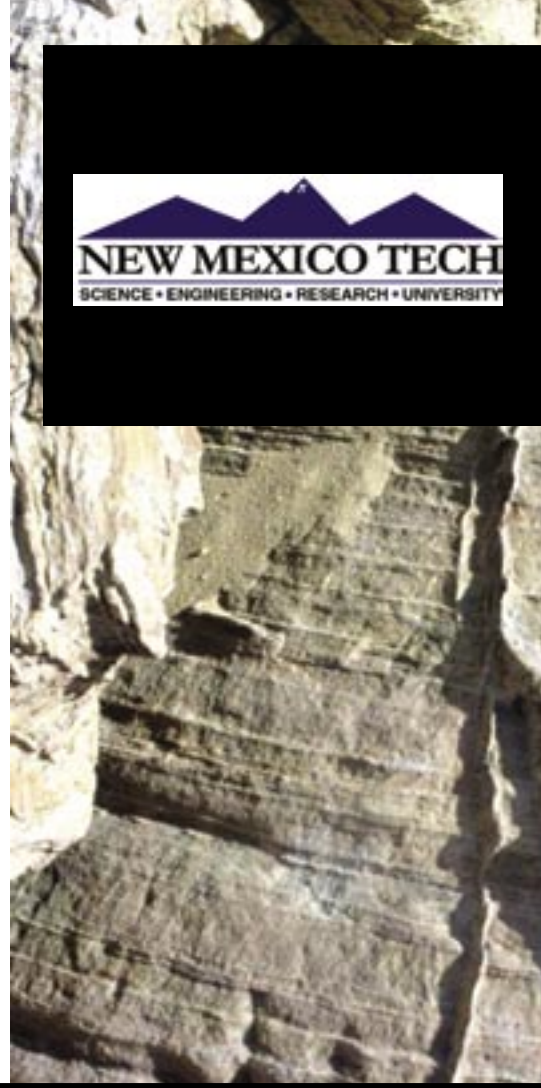
The first course offered at New Mexico Tech was Geol. 572 – Frontiers of Cave and Karst Science taught by Dr. Boston, Spring Semester 2003. Four undergraduate and three graduate students were enrolled. Excellent student feedback ratings were received for this maiden voyage of the course. The course culminated with a three-day field trip to Carlsbad Cavern and Spider Cave at Carlsbad Caverns National Park. In the spring semester of 2004, the course will be offered as Geol. 450/550 with an accompanying laboratory. Development of a meaningful laboratory and field experience in the many facets of speleology has been very challenging, but Dr. Boston looks forward to presenting this class for the first time beginning in January 2004.

Dr. Boston also worked on establishing a specific set of academic curricula in various aspects of speleology to serve as guides for prospective and incoming cave and karst students. These curricula are anticipated to be complete by the beginning of the fall 2004 semester and will be submitted for approval to the New Mexico Tech Faculty Council.

During 2003, New Mexico Tech received more than 30 inquiries from prospective students with cave and karst interests. Some were encouraged to apply to New Mexico Tech and some were put in contact with cave and karst scientists at other academic institutions. Two new PhD students were accepted for the New Mexico Tech fall 2004 program. Four other cave/karst and three karst hydrology applications are under review.

A number of graduate student activities are underway both at New Mexico Tech and other schools that are being supervised by New Mexico Tech Cave and Karst Studies. Additionally, Dr. Boston advises five undergraduate students, two of whom are bound for careers in cave and karst sciences. She also gave several guest lectures during 2003 in other classes (e.g., the basic Geol. 101 course, the Principles of Mineralogy course, and Landforms and Structures class). Dr. Lewis Land was guest lecturer for Boston's class on the use of geophysical tools for cave research and exploration. New Mexico Tech scientists advised in the development of a design course in the International Space University division to be offered at Pennsylvania State University during the spring 2004 semester. This project-oriented course will focus on designing science activities for exploration of caves on Mars and their eventual utilization as human habitat during future crewed space missions.

In September, Dr. Land gave a presentation to the geology department at the University of Texas-El Paso on the role of caves and karst processes in the hydrologic framework of southeastern New Mexico. During this visit, Dr. Land also



Students prepare to enter Wen Cave, N.M., on class field trip.

La Tetera science assessment trip to recently discovered cave in Arizona.

Lewis Land leads a field trip stop during the Decision Makers Field Conference.

MIT students investigate a lava tube.

participated in a radio interview on KTEP, the local public radio station in El Paso, and discussed several aspects of caves, karst research, and NCKRI with Dr. Keith Pannell, who conducted the interview.

K-12 Education

In 2003, a number of students of various ages have contacted New Mexico Tech for information and help with various school projects involving cave or karst issues. The university responded with information, links to websites, images, and project advice.

K-12 outreach activities continued in 2003 with mentoring of several Albuquerque area middle school student science projects for science fair entries. Dr. Boston made a special keynote presentation on cave and karst research for the New Mexico State Science Fair held at New Mexico Tech in April 2003. Dr. Boston also gave a guest lecture on cave science and exploration to the Summer Science Program, a nationally recognized competitive program for gifted high school juniors. This program has been housed in California for more than 40 years, adding New Mexico Tech for the first time in 2003 as a second site.

Dr. Land gave a presentation to the Pecos Valley Grotto (the local chapter of the National Speleological Society in Carlsbad) on the use of geophysical tools for cave research and exploration.

Dr. Boston serves on the expert panel for creation of a new 21st Century initiative exhibit at the Museum of Science and Industry in Chicago. The new exhibit and accompanying public and educational outreach program centers around the theme of Exploration Science. Two meetings took place in 2003 (July 28-29 and Oct. 9-10) and are to be followed by a final meeting in 2004.

Dr. Land has been interacting extensively with the New Mexico Geological Society to promote cave and karst awareness within that regionally important body. In 2004, Dr. Land will serve as the Society's secretary, and in subsequent years is in-line to serve as treasurer, vice-president, and president of NMGS. Dr. Boston has just been named to the editorial board of the Society responsible for publishing the quarterly journal *New Mexico Geology*.

Research Grants and Contracts

This past year, New Mexico Tech engaged in extensive efforts to acquire external funding for new projects in cave and karst science. Several proposals were funded, several were rejected, and three were still outstanding as of January 2004. The funded proposals include a grant from the National Science Foundation Geobiology Program for a comparison of cave iron and manganese microorganisms and their surface desert varnish, counterparts in conjunction with a team at University of New Mexico, Albuquerque. A second funded effort through the National Aeronautics and Space Administration (NASA) ASTEP program will investigate the science of submerged caves in Mexico and the development of autonomous robotic explorers

Student activities in 2003 supervised by New Mexico Tech Cave and Karst Studies faculty included:

Setsuko Shindo,
MS student in Hydrology,
New Mexico Tech, Socorro

Active modeling work and field data acquisition is underway as part of Ms. Shindo's thesis project, which focuses on the micrometeorology of Carlsbad Cavern, under the advisement of Dr. Boston. Ms. Shindo is collecting an extensive set of parameters at various points using new, state-of-the-art sensors, in many cases specially modified for cave use. The modeling effort uses the newest version of FEMLAB partial differential equation-based software in an attempt to understand what governs the interior environment of this famous and well-visited national treasure. Beyond its intrinsic scientific interest, the National Park Service cave specialists at Carlsbad will be able to use the results to better manage the cave.

Misty Milleson,
MS student in Biology,
New Mexico Tech, Socorro

Ms. Milleson has just embarked on a master's degree program in the Biology Dept. at New Mexico Tech. Dr. Boston is a member of her advisory committee. The project is a molecular phylogenetic assessment of microbial activity in the deep subsurface as seen in deep gold mine adits in South Africa. These organisms are in the groundwater found within the deep hydrothermal karst systems within which much of the mining activity occurs. An additional focus of the study will be the search for biominerals that are unique to the cave/karst/subsurface environment.

Morgan Perrone,
MS student in Geology,
NMSU, Las Cruces

Dr. Boston is also serving as primary advisor and outside committee member for New Mexico State University graduate student Morgan Perrone who is pursuing a thesis project in Spider Cave in Carlsbad Caverns National Park. Morgan is looking at the origins of an unusual deposit known as "moonmilk," which occurs in some caves worldwide. The deposits in Spider, known as "Crisco", may come from a unique interaction between microorganisms and the parent limestone rock producing essentially a "living mineral". This project builds upon some of Boston's previous and current research in Spider Cave.

Marion Pfaffenhuemer,
visiting PhD student in Biology,
University of Salzburg, Austria

Ms. Pfaffenhuemer is an advisee of Dr. Helga Stan-Lotter, recognized expert in the microbiology of subsurface halite (rock salt) deposits. Dr. Lotter is interested in comparing the salt bodies at the Waste Isolation Pilot Plant in Carlsbad and the highly metamorphosed rock salt deposits of the Alps in her native Austria. From August 18 until October 5, 2003, Ms. Pfaffenhuemer, worked in Dr. Boston's laboratory to learn some of her cave geomicrobiology techniques. She also worked with scientists D. Northup and M. Spilde at the University of New Mexico in Albuquerque.

for use in both Earth caves and extraterrestrial sites like possible oceans on the Jovian moon Europa. A pilot study has been funded by the NASA Institute for Advanced Concepts to assess technologies for creation of microrobotic cave explorers to access human -inaccessible Earth and extraterrestrial caves. Funded projects will be administered through New Mexico Tech.

To help develop ideas for future funding, Dr. Boston attended the National Science Foundation Regional Conference held in Albuquerque March 23-25, 2003.

Meeting Organization

Lewis Land co-organized and led the New Mexico Bureau of Geology's 2003 Decision Makers Field Conference, *Water Resources of the Lower Pecos Valley*. A major focus of this year's conference was water resources in the karstic San Andres artesian aquifer, the principal source of water for irrigation in the Roswell Artesian Basin. Several stops provided opportunities to examine karst features that contribute to groundwater circulation within the artesian aquifer. Over 50 individuals attended the conference, including several New Mexico state legislators, as well as representatives from several state government agencies, including the Environment Department, Office of the State Engineer, Interstate Stream Commission, and the cabinet secretary for the Energy, Minerals, and Natural Resources Department. Participants also included representatives from the offices of Governor Bill Richardson, Senator Pete Domenici, Senator Jeff Bingaman, and 3rd District Representative Steve Pearce.

Drs. Land and Boston have undertaken organizing the 2006 New Mexico Geologic Society Fall Field Conference as a tour of important karst and cave geology sites in New Mexico. These three-day conferences include extensive lectures and demonstrations in the field. To familiarize themselves with the organization and running of such meetings, Land and Boston attended the 2003 conference.

Dr. Boston served as Technical Chair for the New Mexico Geological Society Annual Meeting held at New Mexico Tech on April 11, 2003. The meeting theme was Caves and Karst. NCKRI Director Hose delivered the keynote speech on caves and the role of NCKRI in promoting cave research, with special emphasis on New Mexico and the southwest.

Van Romero, Vice President - Research & Economic Development

CURRENT NEW MEXICO TECH STAFF
WORKING DIRECTLY WITH THE INSTITUTE:

TITLE	NAME/LOCATION
Director – Cave & Karst Program	Penelope Boston/Socorro
Karst Hydrologist	Lewis Land/Carlsbad
Vice President –Research & Econ. Dev.	Van Romero/Socorro
Associate Vice President	Richard Cervantes/Socorro
Director of Planning	Joe Galon/Socorro

Students in Lab-New Mexico Tech students look at analyses.